covering, the matter is quite different. The more the atmosphere emits (absorbs) the more does the sun's radiation pass in this roundabout way to the higher latitudes, to a large extent in winter but to a less extent in the whole year. In summer its heat conservation is negative, but in winter we benefit from solar radiation which is conveyed to the higher latitudes in a roundabout way by atmospheric radiation. The fact that the "radiation temperature" of central Europe is increased to the extent of 30 to 60 degrees (C.) by the counter radiation of the atmosphere shows that the atmosphere has not received its great capacity for radiating by being irradiated in these latitudes. The general circulation of the atmosphere—which is particularly active in winter on account of the large temperature differences—brings into higher latitudes masses of air capable of radiating and furnished with great quantities of entropy in the equatorial regions. The general circulation may be compared with a huge föhn, which ascends in the tropical belt of calm, flows over the trade-wind region and the horse latitudes and in descending is capable of radiating profusely on account of the high potential temperatures at moderate water vapor content.

In order to decide whether heat is conveyed to the higher latitudes and land masses chiefly only by solar radiation and atmospheric radiation, we have still to take into account the influence of the process of condensation. If water vapor condenses, quantities of entropy become available so that work and the yielding of heat can be combated. If the performance of work is sufficiently small, then in case the condensation takes place at 0°, the yield of heat is about 600 $\frac{\text{gram cal}}{\text{gram}}$ (at −10°, 0°, +10°, it is 613, 607, and 589 cal., respectively). If we take a yearly rainfall of 120 cm, the condensation provides daily about 200 $\frac{\text{gram cal,}}{\text{cm}^2}$ while the counter radiation of the atmosphere is about three times this quantity. Now, Brückner [14] has shown that each drop of rain falls to the ground, on the average, three times before it is again returned to the ocean, consequently two-thirds of the heat made available by condensation is taken up from the land in evaporation. With a yearly rainfall of 120 cm, the quantity of heat brought by the water vapor taken from the ocean and made available by condensation is only 67 $\frac{\text{gram cal,}}{\text{cm}^2\text{, 24 hrs}}$ thus about 10 per cent of the counter radiation of the atmosphere, while over the ocean itself, the ratio is smaller. The gain of heat from condensing water vapor is small compared with the gain by radiation from radiating masses of air warmed in tropical regions.

The investigations of this paragraph were founded on a constant average content of water vapor in the atmosphere. The absorption capacity of the atmosphere as a function of the humidity is far too scantily known for us to be able to take into account with any certainty the variability of the humidity with regard to place and time. This quantity which is of such importance for the conservation of the earth's heat can be obtained by systematic measurements of the counter radiation of the atmosphere by means of the theory developed here.

[14] *Brückner, E.* On the origin of rain. Geographische Zeitschrift, 1900, 2:89.

A TORNADO IN UTAH.

By ARTHUR W. STEVENS, United States Forest Service.

[The following report is transmitted through A. H. Thiessen, meteorologist, Salt Lake City, Utah, who remarks that the phenomenon is so very unusual in Utah that more than ordinary interest attaches to it.]

A small tornado occurred to-day (August 5, 1916) in the valley of the East Fork of the Sevier River about 1 mile north of Dave's Hollow ranger station, elevation 7,800 feet.

As observed from the station, the tornado appeared to have formed a short distance east of Frank Hatch's ranch on the Tropic Road. When first observed it was in the form of a slender inverted cone. It was too far distant to observe any whirling motion, but small puffs of cloud-like smoke were traveling rapidly upward on the outer surface of the cone.

The cone elongated rapidly and took on the shape of a rat's tail. The tip of the cloud did not touch the ground at any time, but directly under it was a large whirlwind that lifted a spray of mud and water from the ground.

The whirling cloud was white and at times appeared almost luminous, probably by contrast with the exceedingly dark cloud back of it.

The tornado lasted about 15 minutes, and traveled not over one-half mile in an easterly direction before breaking up.

After the storm I rode over the area of the storm, but as the only vegetation was sage brush and similar plants not over a foot high, there was no evidence to show exactly where the tornado had passed. The strip of ground affected was probably not over 20 or 25 feet wide, and possibly narrower than that.

This occurred during a period of exceptionally violent local rain and thunderstorms. Ranger Houston, of Dave's Hollow, pronounced it a waterspout, and I think it was so entered in his weather report for the day; but it was undoubtedly the same as the "twisters" of the Middle West, and the occurrence of one west of the Rockies was thought to be sufficiently rare to be worth recording.

THE GOVERNMENT SAFETY-FIRST TRAIN, 1916.

By RUY H. FINCH, observer in charge of Weather Bureau Exhibit.

[Dated Weather Bureau, Washington, Sept. 25, 1916.]

During the summer of 1916 a unique method was pursued in informing the public as to some of the work that is being done by the various branches of the Federal Government.

While a great many people have had an opportunity to visit the different international expositions, and the National Capital, yet the vast majority of our citizens have but little knowledge of Federal activities.

After the Safety-First Convention, held in the New National Museum where most of the departments of the Government had exhibits, the idea was conceived of placing the exhibits on a railway train and giving everyone an opportunity to see what the Government is doing in the way of safeguarding life and property. Accordingly, a selection of exhibits was made and placed in 10 steel coaches, from which the seats had been removed, of the Baltimore & Ohio Railroad. Thus the Government Safety-First Train, a "World's Fair on wheels," originated, and on May 1, 1916, it started on its four months' educational trip.

The exhibits were arranged on both sides of the cars, or so as to leave a passageway from one end to the other,

and the people coming in at one end would pass entirely through the 10 exhibition coaches. Government attendants and demonstrators were stationed beside their exhibits and explained them as the people passed through the train.

The following departments had exhibits: Agriculture, Interior, Navy, War, Treasury, Interstate Commerce Commission, and American Red Cross. The Department of Agriculture was represented by three of its branches—Weather Bureau, Forest Service, and Bureau of Animal Industry—each having one-third of a 70-foot coach.

The Weather Bureau exhibit, shown in figure 1 opposite, consisted of charts and pictures, storm-warning lanterns, a model of a house showing a system of lightning conductors, a glass weather map, and most of the meteorological instruments that would permit of being carried on a train.[1] All were selected with a view of showing, in the small space available, the work of the Weather Bureau in observing and recording weather conditions and forecasting the weather, including frost, cold waves, storms, and floods. A striking chart was one that contrasted the number of lives lost during a hurricane of 1893—before the organization of the Weather Bureau's West Indian service—with the number lost during a storm in 1915. The model house with lightning rods attracted considerable attention and from a practical educational standpoint was second to no other exhibit on the train. The method of forecasting was shown by the aid of the glass weather map, which was drawn every day, and most people expressed themselves as being much pleased with the opportunity of learning the basic principles of forecasting.

The explanation of the instruments was made easy by having them so placed that all could be seen at once. The triple register was in actual operation; an electric light actuated the sunshine recorder, the cups of the anemometer were rotated by an electric fan, a sprinkling can was the source of many showers, and the wind vane could record three different directions. Both tipping bucket and ordinary raingages were exhibited in operation and attracted more attention than any other of the Weather Bureau instruments.

The train was operated by the Baltimore & Ohio Railroad for two months, and one month each by the Missouri, Kansas & Texas Railway and the Union Pacific Railroad companies. In all, it traveled 10,000 miles, was exhibited in 87 cities of 16 different States. The total attendance was 534,000, giving an average daily attendance of 5,180 for the four months that it was on the road.

While the large number of people attending precluded their seeing the exhibits as thoroughly as was desired, yet the trip as a whole was a success.

GRAPHICAL METHOD OF SHOWING THE DAILY WEATHER.[2]

E. T. QUAYLE, Assistant.

[Commonwealth Bureau of Meteorology, Melbourne, Australia.]

(*Reprinted from* Geographical Review, New York, Sept., 1916, 2:233.)

A simple method of keeping a graphic record of the daily weather has many advantages over the usual written description. Mr. E. T. Quayle, assistant in the Commonwealth Bureau of Meteorology of Australia, has recently described a simple scheme for a graphic record which he has used satisfactorily for over twenty-five years. The record deals chiefly with cloud types and their amounts, movements, and changes, but includes also winds, rain, and electrical and other phenomena. The time (hour of the day) is shown along a horizontal line, and the cloud levels are indicated vertically. The cloud forms are represented as seen in section, or as they would appear on the horizon. The level to which the cloud belongs is indicated by the height of its position on the vertical scale of the diagram. The amount of cloud and its duration are partially suggested by the way the stratum is broken or by the addition of a figure to show a numerical estimate. The rate of movement may be shown by different amounts of feathering on arrows which show the direction of movement. Wind directions are indicated by arrows at the bottom of the diagram. Rain, lightning, etc., are suggested by conventional symbols or by sketches. Short supplementary notes may be added when necessary. The illustrations of this method of keeping a graphic weather record, given in Mr. Quayle's report, show the value of the scheme in presenting at a glance a vivid and interesting picture of each day's weather.—*R. DeC. Ward.*

TOWER CLOUD AT SAN JUAN, P. R.

By F. E. HARTWELL, Meteorologist.

[Dated: Weather Bureau Office, San Juan, P. R., Aug. 16, 1916.]

About half an hour before sunset August 15, 1916, at San Juan, P. R., the sky being otherwise absolutely clear, a large flat-topped cumulus cloud was observed silhouetted against the western sky. A perfectly smooth band of false cirrus lay across the top and extended over the edge of the dark cumulus, the formation being such that it seemed to indicate the foreshortening of a wide curve in the overhanging edge of the band, which was luminous from the setting sun behind it.

From this stage the cumulus rapidly assumed the formation of [a wide cumulus chimney] with a cap of the false cirrus arranged in four distinct bands, thin enough to show their circular form; the top and broadest band was luminous, the other three narrow ones were in the shade of the dense cloud. No motion could be detected in these bands, so smooth was their texture, but it would seem that they could have been held in such a form only by a circular motion. These bands persisted with very little change for 20 minutes or more, the upper disk or band disappearing first and then what appeared to be the edges of two similar disks appeared a little below the bases of the original narrow disks.

The height of the cloud at its maximum development with its triple crown was about 30°; there were frequent lightnings through the middle of the cloud column, but the distance was so great that no thunder was heard.

The above note and description, with its unpublished sketches, relates to a cloud form rarely if ever *reported* from the Western Hemisphere. Similar and related forms have been figured and described in the Meteorologische Zeitschrift, notably in its issue for January, 1896 (**13:** 14–15 with Tafeln I, II).

The present form differs in some details, however. There are no radial fringes suggestive of matter being hurled out from within the bands (cf. sketch in Met. Ztschr., Nov., 1901, **18:** 527); neither is there a strongly developed over-hang to the bands; the sketch shows but a slight leaning outward.

Mr. Hartwell does not mention associated hail falls, and we must wait for later reports before it can be asserted that in this case the cloud is properly termed a Hagelturmwolke (hail-tower-cloud), as was the one described by Streit in the Meteorologische Zeitschrift.—C. A., jr.

[1] The objects of this exhibit were illustrated in more detail in the plates facing pp. 452-3, of the REVIEW for September, 1916.

[2] *Quayle, E. T.* A graphical method of showing the daily weather, especially cloud types. Melbourne, 1916. (Commonwealth Bureau of Meteorology, Bulletin 12.)